

## **Continuous Dynamic Grid Adaptation in a Global Atmospheric Model**

William J. Gutowski and Joseph M. Prusa  
Iowa State University  
Ames, IA 50010

The focus of this project is to extend development and testing of a global atmospheric model with dynamic grid adaptation capability. The model is based upon the anelastic approximation for deep moist convection following Lipps and Hemler (1982); and uses nonoscillatory, forward-in-time numerical schemes. It has options for either Eulerian (MPDATA scheme of Smolarkiewicz et. al., 2001) or semi-Lagrangian (Smolarkiewicz and Pudykiewicz, 1992) integrations. Options for either warm (rain only) or cold (rain and ice) moist thermodynamics using the cloud microphysical parameterization of Grabowski, (1999) also exist.

The capability for grid adaptation derives from the model's formulation in terms of a generalized coordinate system that is homeomorphic with spherical coordinates (Prusa et. al., 2001; Smolarkiewicz and Prusa, 2001). In particular, the horizontal coordinates on the sphere can be any transformation of latitude and longitude that preserves the topology of spherical coordinates. The vertical coordinate is treated separately with a time variable generalization of the terrain following transformation (Gal-Chen and Somerville, 1975). One additional transformation applied to the vertical coordinate allows it to be further stretched in any time variable, nonuniform way that preserves its topology.

At the present time, the generalized coordinates have been implemented throughout the dynamical core of the global model. In this project, the implementation will be completed by extending the transformation throughout the thermodynamic and diagnostic routines. We also plan to add soil-moisture and planetary boundary-layer schemes in order to make more realistic global simulations but with regional emphasis. An additional key component of the study will be the continued development of analytical and numerical (Iselin et. al, 2001) transformations that will be beneficial in enhancing the accuracy of climate simulations based upon idealized dry and moist climate scenarios.

### **References**

Gal-Chen, T. and C. J. Somerville, "On the use of a coordinate transformation for the solution of the Navier-Stokes equations. *J. Comput. Phys.*, 17, 209-228 (1975).

Grabowski, W.W., "A parameterization of cloud microphysics for long-term cloud-resolving modeling of tropical convection", *Atmos. Res.*, 52, 17-41 (1999).

Iselin, J.P., Prusa, J.M., and W.J. Gutowski, "Dynamic grid adaptation using the MPDATA scheme", to appear in *Mon. Wea. Rev.*, 20 pps, 2001.

Lipps, F.B. and R.S. Hemler, "A scale analysis of deep moist convection and some related numerical calculations", *J. Atmos. Sci.*, 39, 2192-2210, 1982.

Prusa, J.M., Smolarkiewicz, P.K., and A.A. Wyszogrodzki, "Simulations of gravity wave induced turbulence using 512 PE CRAY T3E", to appear in Int. J. Applied Math. Comp. Sci, 11, 14 pps, 2001.

Smolarkiewicz, P.K. and J.A. Pudykiewicz, "A class of semi-Lagrangian approximations for fluids", J. Atmos. Sci., 49, 2082-2096 (1992).

Smolarkiewicz, P.K., Margolin, L.G., and A.A. Wyszogrodzki, "A class of nonhydrostatic global models", J. Atmos. Sci., 58, 349--364 (2001).

Smolarkiewicz, P.K., and J.M. Prusa, "VLES modeling of geophysical fluids with nonoscillatory forward-in-time schemes", Proc. ECCOMAS Computational Fluid Dynamics Conference, September 4-7, Swansea, Wales, UK, 30 pps, (2001).